On the Sale of Disguised Protectionism

Michael Margolis
(Escuela de Economía, Universidad de Guanajuato)
Jason F. Shogren
(Dept. of Economics, University of Wyoming)

Abstract

Current international law strongly favors polices designed to make imports safer, in terms of invasive species, infectious diseases, or smuggling opportunities, over policies explicitly designed to discourage imports. We show that this preference may be counterproductive. A simple externality in trade is incorporated into a political-economy model of policy formation. Nations can address the externality by inspecting cargo and imposing a fine on contaminated imports. We compare the equilibrium when this is the only policy option to that emerging when nations may also manipulate the tariff. Under some circumstances ruling out the tariff reduces social welfare and increases the cost of importing.

Disguised protectionism is a common charge leveled at obstacles to international trade flows contained in policies explicitly aimed at environmental, product safety, or other market-failure rooted goals. Attention to such obstacles has increased in recent years, and there appears to be wide agreement that this is to be expected as openly protectionist measures are removed through negotiation. A typical expert comment is that of J.B. Penn, a U.S. Agriculture Department undersecretary, discussing a fracas over Russian poultry-plant inspections in December of 2004: "As quotas and tariffs become less important trade barriers, sanitary measures are becoming a relatively much bigger problem" (Wall Street Journal, 2004).

We show in this paper that a variant of the most prominent model of trade-policy formation (Gene Grossman and Elhanan Helpman 1994 – GH hereafter) predicts that such measures will become absolutely larger – not just relatively larger because the old barriers are smaller. More precisely, there will be an increase in the amount of inspection aimed at insuring imports conform to environmental, food-safety, anti-smuggling, anti-terrorist or other standards which can serve as disguises for protectionist intent. We also show, by example, that the increase in inspection can be so great as to result in an effective level of protection higher than that resulting from explicit tariffs formed under the same political pressures. Even when this is not the case, social welfare can be reduced when a country agrees to reduce a tariff, even though the tariff was above the social optimum beforehand.

The example we use to describe our model is that of a country seeking to keep out an alien species. Invasive species was our problem of interest we started this line of inquiry , and it may also prove one of the thorniest classes of trade problems. Alien species can cause crop loss, hazards to navigation, the extinction of species endemic to the host region and other large ecosystem changes, and they interact with many other drivers of global environmental change (see e.g., Wilcove et al. 1998, Sala et al. 2000, Rosenzwieg 2001, Lodge 2001, Mack et al. 2000, Mooney and Hobbs 2000).[1] The international movement of people, goods, and raw materials has amplified the rate at which species move beyond their natural environs "by a hundred-fold to a million-fold" (Lodge 2002). These biological invaders move to new locals through infected cargo, packing material, and ballast water, escape or release from private owners through the biological supply trade, and the live food trade (National Invasive Species Council 2000, 2001). Thus alien pest species loom large among the small class of environmental problems caused by trade itself, and for which trade-restricting measures may be among the best instrument. By contrast, many other forms in which disguised protectionism is alleged – e.g., product standards designed in such a way that domestic producers have an easier time complying – are responses to problems that can in principle be addressed most efficiently with no protectionist side effect.

Nations seeking to keep such a species from becoming established generally prohibit the import of the species itself and restrict the import of material on which it can travel. Policies of this sort have the essential property of a tariff – they add to the cost of importing, and therefore raise the prices of import-competing goods – even when motivated purely by a desire to protect public goods. To say that a policy of this type constitutes disguised protectionism is to say it is "too stringent" - a quantitative judgment implying an estimate of the optimum level of stringency.

This sort of quantitative judgment has no standing in the main international trade agreement governing policies aimed at alien pests, the Agreement on Sanitary and Phytosanitary (SPS) Protocols. Measures are deemed out of compliance with the SPS agreement only if they fail one of several qualitative tests – for example, if not based on a scientific assessment of risk. One can see why the agreement was written this way; estimation of optimal levels of environmental stringency is an ongoing sequence of contentious issues within each nation, and it would surely not have been possible to agree to a single set of protocols covering all such issues globally. But in the absence of such universal protocols, disguised protectionism taking the form of excess stringency can develop unchecked. Alien pest policies could therefore emerge as a privileged class within trade law, one of only a few areas in which countries can set trade-impacting policies without real supervision by the World Trade Organization (WTO).[2]

Besides the need for a scientific risk assessment, the main WTO restriction on national policies to keep out unwanted species is that the policies be "necessary". A policy is considered unnecessary under trade law if there is a less trade-restrictive alternative that achieves the same level of environmental protection, unless that alternative has other disadvantages of comparable magnitude (WTO 2002). Our results suggest that this doctrine be employed with extreme caution, and perhaps reconsidered. A policy with the explicit purpose of reducing imports – a tariff, in our model – is likely to be deemed more trade-restrictive than stringent inspections. We show that this appearance may be deceptive, and that even when it is not so, the tariff may be socially less inefficient than the alternative of excessive stringency. If the purpose of trade agreements is to limit the ability of organized interest groups to obtain policies that reduce the general welfare[3], then current trade laws are likely to run counter that purpose.

The remainder of the paper is organized as follows. In Part I we present a variant of the GH model to incorporate an externality in trade. In Part II we analyze the equilibrium when all policy variables can be set freely. In Part III we examine the equilibrium when the tariff is bound at a level below that which would prevail in the equilibrium found in Part II. The discussion shows how the problem can be usefully broken down into an examination of the impact of binding the tariff on the optimum and the impact of the shift in social optimum on the political-economy game, and the possibility of several classes of outcome becomes evident. In Part IV, we restrict the supply and demand curves to be linear, which allows more useful statements of the circumstances under which the various perverse outcomes are likely.

I. Model

For simplicity, assume a two-good world, with the home country exporting the numeraire good and invasive species entering only accidentally as stowaways on imports. Government sets three policy variables: a tariff τ; a fine F imposed on importers of shipments found to be contaminated; and a level of inspection stringency Σ, which measures the time and resources put into inspections to detect contamination. A shipment is said to be contaminated if there any specimens of an undesirable species in the shipment. This is a performance measure, although the examples above and most others in the real world are process measures. We examine a performance standard partly because there are efficiency reasons to favor performance measures in general, but mostly for ease – this restriction simplifies the relation between damage and expenditure – and because it seems unlikely to matter much for the questions at hand.

Let Ψ be the level of decontamination effort undertaken by importers. Assume both inspection and decontamination processes are characterized by constant marginal cost, so that total costs per unit of import are $k\Sigma$ and $c\Psi$. This is without loss of generality, since it merely defines the previously undefined units of stringency as one dollar's worth of services. Let $l(\Psi)$ be the probability that a shipment is contaminated, and $p(\Sigma)$ the probability that contamination is discovered by the government's inspectors, conditional on being present. Assume

$$\begin{aligned} & l' < 0,\ l'' > 0, \lim_{\Psi\to\infty} l' = 0 \\ & p' > 0, p'' < 0, \lim_{\Sigma\to\infty} p' = 0 \end{aligned} \tag{1}$$

which reflects decreasing returns in the inspection or decontamination process as increasingly rare specimens are sought. As inspectors are added, marginal returns eventually approach zero, which means p and l asymptotically approach some value. These may be $p=1$ and $l=0$, so that the preventive measure approaches a perfect success rate; or they may be bound to some level short of perfection.

We make use of two further assumptions on decontamination technology, the interpretation for with are less obvious. First, $(l')^2 < l\,l''$, which rules out the possibility that an increase in the inspection level Σ results in so much decontamination effort as to reduce the number of specimens being found by inspectors (see (8) below). Second, $2(l'')^2 > l'\,l'''$. This is sufficient to insure that the amount of decontamination effort increases at a decreasing rate as inspection rises. (The second order curvature would otherwise be ambiguous.) We shall refer to these assumptions collectively by saying that importers are not *hyper-reactive* to inspections. There is no general reason to believe that decontamination production functions must always obey these assumption, and the behavior of hyper-reactive importers may be interesting to study. The simple parameterization we have used for simulations (see bottom line of Table 1), however, gives non-hyper-reactive importers globally.

Assume importers are risk-neutral perfect competitors, so that the domestic price of the import equals the world price plus expected costs of importing

(2) $$p^D = p^W + t + c\Psi + F\,l\,(\Psi)p\,(\Sigma)$$

Assume the import competing industry is perfectly competitive with supply curve $y(p)$. In autarky the price would be p^A, where this supply intersects the domestic demand curve $D(p)$. The cases of perfectly elastic supply and demand are allowed separately, but we require that at any given price at least one of the two curves has non-zero slope, so that the slope of imports as a function of domestic price is never zero. Trade lowers the price of the imported good to p^D, so that consumers gain $\int_{P^D}^{P^A} D(p)dp$ and producers lose $\int_{P^D}^{P^A} y(p)dp$. The total change in surplus is therefore

(3) $$\int_{P^D}^{P^A} D(p)dp - \int_{P^D}^{P^A} y(p)dp = \int_{P^D}^{P^A} m(p)dp\,.$$

Assume marginal expected damage per entry is a constant d, and that the social welfare function is risk neutral. Total expected damage is then $d\,l\,(\Psi)\left(1 - p\,(\Sigma)\right)$. The total gains from trade net of the external effect and inspection cost are

(4) $$W = \int_{p^D}^{p^A} m(p)\,dp + \left(t + F\,l p - k\Sigma\right) m(p) - d l \,(1-p) m(p)$$

The integral is the total change in consumer and producer surplus due to trade. This includes the resources used to decontaminate imports, since these are passed on to consumers in the form of higher price. The money used to pay the fines and tariffs are included by the same logic, but since these are transfers, rather than real expenditure of social resources, they are added back in the second term. As usual, the assumption is that revenue paid to government is passed on to consumers as a lump-sum payment. The term subtracted is total external damage due to trade – damage per invasion event , times undetected invaders per import, times imports.

Assume the fine is constrained not to exceed an exogenous maximum, $\bar{F}$. There are couple of reasons for this assumptions. Fines exceeding the value of a single ship and its cargo could be countered by the division of firms into one-ship operations to truncate the fines. Alternately, a limit may be placed on the size of the fine by the need to prevent corruption of inspectors. It is worth noting, however, what would happen if infinite fines are allowed: tariffs will never be used, and inspection levels will always be set at the minimum. This is because any benefit that can be gained by increasing inspections, at cost, can also be achieved by increasing the fine, which is free (it is just a transfer from consumers of the import to taxpayers) And any protectionist gain that can be achieved by a tariff can be achieved by a sufficiently high fine, with the added benefit of environmental protection. In equilibrium, then, the fine will always be set at $\bar{F}$. This is generally the case in models of optimal enforcement (A. Mitchell Polinsky and Steven Shavell 1979; 2000).

Since the importers are perfect competitors, they disregard the collective impact of their decisions on the regulator's choices of Σ, and each chooses Ψ to minimize its own expected cost, $t + c\Psi + F\, l\, p$. Denote the cost-minimizing level of decontamination Ψ^*. The first order condition on the cost minimization problem is

(5) $$c = -Fp(\Sigma)\, l'(\Psi^*).$$

and the function

(6) $$\Psi = \Psi^*\left(\Sigma, F\right)$$

implicitly defined in (5) has unambiguously signed derivatives

(7) $$\Psi_F^* \equiv \frac{\partial\Psi}{\partial F} = -\frac{l'}{F\, l''} > 0$$

and

(8) $$\Psi_\Sigma^* \equiv \frac{\partial\Psi^*}{\partial\Sigma} = -\frac{p'l'}{p\, l''} > 0.$$

Not surprisingly, firms respond to higher fines or more stringent inspections at the port by increasing the stringency of their decontamination activities.

We determine how the policy variables are set by extending the GH model of interaction of interest groups and government.[4] Our central story is clearest if we assume the only organized group consists of owners of a specific-factor used to produce the imported good -- i.e., they are the import competing industry.[5] Assume further that the members of this lobby group constitute a negligible fraction of the population, so that when they lobby, their motive to transfer money from the public to themselves is not mitigated by the fact that they are part of the public. This is the case in which disguised protectionism should be greatest, there being no political counter to the lobby except government's concern with the general welfare.

Government cares both about general welfare and about campaign contributions. Such a government objective function can arise from the desire of political parties to remain in power. Consider a body of incumbents which views its reelection probability as greater if society is better off, and also as greater if it can spend more on elections. Some of them may also want social welfare high for altruistic or idiosyncratic reasons - it makes no difference to the theory. The relative weight the incumbents place on social welfare versus campaign contributions is assumed constant, regardless of the origin of contributions or whether increments to social welfare take the form of environmental improvement, a rise in consumer surplus, or a rise in government revenue. This is represented by a government objective function

(9) $$G = C(p) + aW(p, \delta m)$$

where *a* is the exogenous weighting of consumer welfare and *C* is the campaign contribution given by the lobby; the contingency of *C* on the import price will be explained shortly. Objective (9) differs from that in GH only by the inclusion of a damage term in the welfare function and by the simplification to a two-good world. Lobbyists' contributions to the government are determined by the following process. Before the government makes its decision, the lobby draws up a *contribution schedule*. This schedule is a perfectly binding agreement that commits the lobbyist to contribute a specific amount for every policy choice the government might make. We abuse notation slightly and write the contribution schedule offered by the lobby as a function of prices,

$C(p)$. More precisely, we could write it as $C(\Sigma, \tau)$, but there is no reason for import-competing producers to care which policy is used to increase their prices.

The government's objective function and the announced contribution schedules are assumed common knowledge, and the contribution schedules are announced before the policy decision. This structure is in the class of problems known as *menu auctions*, the general properties of which were examined by Douglas Bernheim and Michael Whinston (1986). Two properties matter for our context. First, lobbies are likely to exploit *truthful strategies*: that is, the contribution schedule is such that the lobby is indifferent as to which policy ultimately gets chosen among those for which it is willing to make some positive contribution.. Bernheim and Whinston showed that among the possible best responses of any player in any menu auction game, there exists a truthful strategy. Further, if any communication among players is possible, equilibria composed of truthful strategies are, for practical purposes, the only stable ones. Roughly speaking, non-truthful strategies can be undermined by coalitions, even when there is no mechanism available to enforce agreements. For this reason (and following GH) we consider only truthful strategies.[6]

The second feature is that the Nash equilibrium in a menu auction must maximize the joint payoff of the auctioneer (i.e., government) and bidder (i.e., lobby).[7] This means that $C(p)$ cannot be part of a Nash equilibrium with price p unless it maximizes

(10) $$W_I\left(p^D\right) + aW\left(\mathrm{F}, \Sigma, t, \Psi, p^D\right)$$

subject to the limit on the fine and importer reaction and price effect constraints, where W_I is the welfare (gross of contributions) of a representative member of the lobby group.

The equilibrium conditions on the policy setting game are therefore the same as the optimization conditions for the constrained maximization of (10). For convenience, we list here the conditions that arise with the limit on the fine set aside, then carry the fine-ceiling constraint through the rest of the analysis explicitly. The Lagrangian for the resulting problem (maximize (10) subject to (6) and (2)) is

(11)
$$\max_{F,\Sigma,t,\Psi,p^D,m_p,m_\Psi} \Lambda = W_I\left(p^D\right) + aW\left(F,\Sigma,t,\Psi,p^D\right) + m_p\left[p^D - \left(p^W + t + c\Psi + F\,l\,p\right)\right] + m_\Psi\left[\Psi - \Psi^*\right]$$

The welfare of the lobby group is the profits of the import competing industry, so by the envelope theorem the derivative of W_I is $y(p^D)$. Making use of this observation and the functional form for W from (4), the first derivatives of Λ with respect to those choice variables (apart from the Lagrange multipliers) are

(12)
$$\frac{\partial\Lambda}{\partial F} = \left(am - m_p\right) lp - m_\Psi \Psi^*_F$$

(13)
$$\frac{\partial\Lambda}{\partial\Sigma} = \left[\left(d + F\right) lp' - k\right] am - m_p F\,lp' - m_\Psi \Psi^*_\Sigma$$

(14)
$$\frac{\partial\Lambda}{\partial t} = am - m_p$$

(15)
$$\frac{\partial\Lambda}{\partial\Psi} = \left[am\left(Fp - d\left(1-p\right)\right) - m_p Fp\right] l' - m_p c + m_\Psi$$

(16)
$$\frac{\partial\Lambda}{\partial p^D} = y\left(p^D\right) + a\left[\left(t + F\,lp - k\Sigma - d\,l\left(1-p\right)\right) m' - m\right] + m_P$$

In what follows, we use these derivatives in various combinations to generate first order conditions (and one Kuhn-Tucker complementary slackness condition) of greater intuitive significance than would result from considering one at a time.

II. Equilibrium when tariffs are allowed

At an interior equilibrium, the derivatives in (14) and (16) must be zero; it follows that the *unbound tariff* $\tilde{t}$ obeys

(17) $$\tilde{t} + \tilde{F}\,\tilde{l}\,\tilde{p} = \left[k\tilde{\Sigma} + d\,\tilde{l}\,(1-\tilde{p})\right] - \frac{\tilde{y}}{a\tilde{m}'}$$

where the ~ denote values taken on by variables or functions at the unbound equilibrium. The second term on the left side, *F?p*, is the expected fine paid per ship. The entire left side is thus the expected payment to customs per unit import, which we refer to as the *augmented tariff*. (The phrase *effective tariff* we reserve to refer to the entire difference between world and domestic price, including the component not paid to the government – i.e. the augmented tariff plus decontamination cost.) The term in square brackets is the optimal level of that expected payment – that is, the marginal external cost of a unit of import. This marginal cost consists of the inspection cost $k\Sigma$ plus the damage from units not caught $d\,l\,(1-p)$. The final term is our measure of disguised protectionism, to the extent it is captured in the tariff.

This disguised protectionism term is identical to that which would emerge if the tariff were the only possible policy (see Michael Margolis et al., 2004). The term is also the same as the tariff level in GH, in which there is no externality with which the protectionist policy can be disguised. The nominal tariff, however, differs among these three cases. In GH, the nominal tariff is simply $\left|\frac{y}{am'}\right|$; in Margolis et al. (2004), it is $\left|\frac{y}{am'}\right| + d$; in the present case, too, the *augmented* tariff equals $\left|\frac{y}{am'}\right|$ plus import damage, but that damage is lower thanks to the inspectors, and the nominal tariff differs from the effective by the expected fine. For both these reasons, the nominal tariff is lower when the inspection policy exists than it would be if inspections were impossible.

Consider now the level of inspections, $\tilde{\Sigma}^A$. Setting (13)- (15) to be zero gives

$$k = d\tilde{l}\tilde{p}' - \left[c + d\left(1-\tilde{p}\right)\tilde{l}'\right]\tilde{\Psi}^*_\Sigma . \tag{18}$$

This is the same condition that must hold for a social optimum: marginal inspection cost k equals marginal social benefit. That benefit consists of the directly avoided environmental damage, plus the damage avoided by induced decontamination $\left(-d\left(1-\hat{p}\right)\hat{l}'\hat{\Psi}^*_\Sigma\right)$ net of decontamination expenditures $\left(c\hat{\Psi}^*_\Sigma\right)$

Finally, consider the fine: substituting $m_p = am$ (from (14)) into (12) gives

$$\frac{\partial \Lambda}{\partial F} = -m_\Psi \Psi^*_F > 0 \, \forall F .$$

The sign follows because $\Psi^*_F > 0$ and $m_\Psi = d\left(1-p\right)m\,l' < 0$ from (15). Any equilibrium with positive tariffs therefore includes the maximum possible fine, and this also holds for any optimum with positive tariffs.[8] We discussed this matter when the maximum fine constraint was introduced.[9]

We have shown that, if a tariff on environmentally risky imports is allowed and can be set at any level, the tariff is the only instrument through which disguised protectionism is expressed. The remaining policy variables are set at their optimal levels. The augmented tariff exceeds the optimum by the same function of the import-competing industry size, import elasticity, and the weight placed on social welfare as prevails when a tariff is the only option. The existence of a policy aimed more narrowly at the environmental externality does change the tariff , but not by altering the ability of lobbyists to achieve tariffs above the optimum. Rather, it changes the optimal tariff, which now involves a more complex set of trade-offs involving inspection costs and fine revenues in addition to the external damage.

Ultimately, this is so because the equilibria of political games maximize weighted averages of player objectives, as in expression (10). Political games result in socially inefficient policies, sacrificing some social welfare to redistribute what is left to those with influence: but they do not sacrifice more welfare than necessary to achieve that redistribution. The political influence game does not choose inefficient instruments. Troy Aidt (1998) found a similar result and dubbed it the "political economy version of Bhagwati's principle of targeting": political economy games select the policy instrument most directly aimed at each goal, so long as enough instruments are available. The goals here are social welfare improvement and campaign contributions, the latter achieved by redistributing income from consumers to influential firms. Tariffs can redistribute income more efficiently than can playing with the inspection level. As long as tariffs are possible the government will choose them.

That intuition requires one refinement: the tariff also serves a welfare-enhancement function, internalizing the externality in trade that remains because inspectors are costly and do not catch every contaminant. Also, the inspection regime of necessity does some of the tariff's job because it raises the cost of importing. It is possible for the inspection level satisfying (18) to discourage more trade than is optimal, in which case the optimal tariff is negative. This occurs, for example, if the fine is extremely high and port inspectors are extremely effective. In this case, the equilibrium tariff may also be negative – but it will be a smaller import subsidy than is optimal.

III. The impact of binding the tariff:

The results so far might be taken to indicate that a country is better off if, prior to setting loose the political system to set policy, it rules out the use of tariffs. For a country large enough to affect world prices, this restriction is likely to be welcomed by its trade partners.[10] This is roughly the approach of current trade agreements, in which policies aimed directly at trade (tariffs and quotas) are tightly controlled, while those aimed at invasive species or similar externalities can be set freely unless it can be shown that a less trade restrictive policy would achieve the same level of safety. In this section, we consider the problem of a country that has agreed to limit its use of tariffs. We assume the agreement is binding - i.e., the tariff ceiling is below what would otherwise be the equilibrium tariff – the alternative case being trivial. In our graphical illustrations, we assume the tariff is bound at zero.

Given this ban, a social optimum is the solution to the problem of maximizing W over $\left\{F, \Sigma, p^D, \Psi\right\}$ subject to the domestic price equilibrium condition (2) , the importer reaction condition (6), and the upper bound on the fine.. The equilibrium is the maximum of $W_I + aW$ subject to the same constraints. In both cases, assuming conditions are such that a positive tariff would be chosen if it were allowed, the solution includes the maximum fine. This follows from the observation that prohibiting the tariff drives m_p above *am* (see (14)), so the change in the derivatives with respect to the fine only strengthens the earlier argument.

Setting the derivatives in (13), (15) and (16) to zero and substituting for c from (5) gives the following expression for the augmented tariff in the bound equilibrium

$$(19) \qquad \hat{t}+\bar{F}\,\hat{l}\hat{p}=k\hat{\Sigma}+d\hat{l}\,(1-\hat{p})-\frac{\hat{y}}{a\hat{m}'}+\frac{\hat{m}}{\hat{m}'\bar{F}\,\hat{l}\,\hat{p}'}\Big[k-d\hat{l}\hat{p}'+\big[c+d\,(1-\hat{p})\,\hat{l}'\big]\hat{\Psi}^{*}_{\Sigma}\Big]$$

As in the unbound case, the condition for a social optimum differs from that for truthful-strategy Nash equilibrium only by the term y/am'. In contrast to the unbound case, however, almost every variable takes on different values in equilibrium and optimum, because almost all are functions of Σ. Where required below, we will distinguish the levels of these variables with the subscripts *eq* for equilibrium and *opt* for optimum, but for most of the discussion this notation is not needed.

We refer to the right side of expression (19) as the *target* level of the augmented tariff, thinking of it somewhat loosely as the level of protection for which an agent wanting to achieve the truthful-strategy equilibrium of the inspection-setting game would aim. This target levels is in contrast to the *actual* augmented tariff which is, by definition, the left hand side of (19).

The right hand side of (19) can be partitioned into three components: the external cost of imports, ; the disguised protectionism term ; and the binding adjustment. The binding adjustment is the only difference between (19) and (17), which gives the augmented tariff in unbound equilibrium. Write the binding adjustment using $E(\Sigma)$ as

$$(20) \qquad \mathrm{B}(\Sigma)=\frac{m}{m'\bar{F}\,l\,p'}\big[E'(\Sigma)+c\Psi^{*}_{\Sigma}\big]$$

Economically, the binding adjustment measures the social loss per import discouraged from using inspections as a tariff substitute. To see this, consider first the component in square brackets: the difference between marginal social cost of and marginal social benefit of inspections, *excluding* the trade reduction benefit. Thus, this measures how inefficient this inspection level would be if the tariff instrument were available. This is per shipment; multiplying by m gives the economy-wide aggregate. The denominator is the change in imports due to adding one more inspector per ship: the slope of import demand times the change in augmented tariff due to the marginal inspector.

The binding adjustment applies both to the optimal augmented tariff and to the truthful-strategy Nash equilibrium augmented tariff. This is easiest to see by noting that $\mathrm{B}(\Sigma)$ does not contain the parameter a, and is therefore invariant with respect to the weight policy makers place on the general welfare. Somewhat more laboriously, repeating the analysis above with objective function W rather than $W+aW_I$ results in an augmented tariff that differs from that in (19) only by $\left|\frac{y}{am'}\right|$ -- exactly the same term for disguised protectionism that emerged when the tariff was allowed, and in previous work in which inspections were impossible (Margolis et al., 2004).

This illustrates the first surprising point to emerge from our analysis: *binding the tariff works by changing the social optimum*. In the lobbying game, the social optimum is the government's outside option – that is, it is what they choose if the lobby offers nothing. The change in that outside option, being common knowledge, leads to changes in the lobby's bid. The outside option change and the induced-bid change jointly leads to a different equilibrium. Once the government's outside option has shifted, the game with the lobbyists plays out just as it would with no externality at all, leading to a level of disguised protectionism dependent on the size of the domestic industry y and the import elasticity m'. The impact of tariff binding can thus be understood by answering two questions. First, what is the impact on the optimum? Second, how does a change in the optimum affect the equilibrium?

III.A. The impact of tariff binding on the optimum inspection level in general

To establish the impact of tariff binding on the optimum, note first the behavior of the optimal target tariff in the neighborhood of the unbound optimum. With each new inspector $E(\Sigma)$ changes by $E'(\Sigma) = k + d\left((1-p)\, l'\Psi^*_\Sigma - lp'\right)$. From (18) we know that at the unbound level of inspections, $\tilde{\Sigma}$, $E'(\tilde{\Sigma}) = -c\Psi^*_\Sigma < 0$. The external cost of trade is thus a decreasing function of Σ at $\tilde{\Sigma}$.

It is immediate that the binding adjustment is zero at $\tilde{\Sigma}$ (see (20)). Further, in that neighborhood the bracketed term in (20) is an increasing function of Σ due to the second-order condition that make (18) a minimum rather than a maximum. Since this term is multiplied by a strictly negative term (due to m'), the binding adjustment is a decreasing function of Σ passing through ($\tilde{\Sigma}$,0).

These observations are sufficient to establish that a tariff ceiling below the optimum results in an increase in the inspection rate. Since $E(\Sigma)$ and $\mathrm{B}(\Sigma)$ are both declining at $\tilde{\Sigma}$ their sum, which is the optimal bound augmented tariff target, is also declining. We show in Appendix A that $E(\Sigma)$ is globally convex; therefore $E(\Sigma)$ is greater for all $\Sigma < \tilde{\Sigma}$ than it is at $\tilde{\Sigma}$, and from (20) $\mathrm{B}(\Sigma) > 0$ for all $\Sigma < \tilde{\Sigma}$. Hence the optimal bound augmented tariff cannot be lower for any $\Sigma < \tilde{\Sigma}$ than it is at $\tilde{\Sigma}$. Also, for a given nominal tariff, the actual augmented tariff $t + F\,lp$ is strictly increasing in Σ for all Σ, since both l and p are increasing and F is bound at $\overline{F}$. Finally, to say that the tariff ceiling is below the optimum is to say that the actual augmented tariff is below the target at $\tilde{\Sigma}$. Thus, to bring target and actual into equality requires $\Sigma > \tilde{\Sigma}$.

This result is illustrated in Figure 1 for a tariff ceiling of zero. When a tariff is permitted, the optimal policy is to set inspections at $\tilde{\Sigma}$ (for reasons not shown in the figure). The optimal augmented tariff is then $\tilde{t}^{a}_{opt}$, equal to the external cost of trade $E(\Sigma)$ (the thin curve). The optimal nominal tariff, shown on the right side of the figure, is $\tilde{t}^{a}_{opt} - F\,\tilde{l}\tilde{p}$. If the country agrees to eliminate the tariff, the optimal inspection level shifts to $\hat{\Sigma}$, given by the intersection of the two fat curves – i.e., where the augmented tariff given by $F\,l\,p$ equals the optimal target augmented tariff $E(\Sigma) + \mathrm{B}(\Sigma)$.

We have not so far addressed the second-order conditions related to the bound maximization problems. As the figure suggests (and simulations prove) these need not hold at every extremum, i.e., the problem may have a local minimum as well as a local maximum. But since the actual augmented tariff must rise to the target from below, it must have greater slope. [11] Thus at the *first* intersection of target and actual, $E'(\Sigma) + \mathrm{B}'(\Sigma) < \bar{F}\,l\,p'(\Sigma)$, which is the second order condition for maximization of social welfare over Σ. Thus, as one increases Σ from the unbound optimum, a local maximum will be encountered before a local minimum. The possible existence of a minimum at still higher inspection rates is irrelevant. The argument is exactly parallel if what is being maximized is not social welfare but the weighted sum of welfare and industry profits which must be at a maximum in truthful Nash equilibrium, the only difference being that the target is in that case $E(\Sigma) + \mathrm{B}(\Sigma) - \dfrac{\hat{y}}{a\hat{m}'}$.

In the case shown, the optimal augmented tariff is reduced by tariff binding – i.e., $\hat{t}^a_{opt} < \tilde{t}^a_{opt}$ – even though the optimal inspection level has risen; however, the curvature of $E(\Sigma) + \mathrm{B}(\Sigma)$ at high levels of inspection leads one to wonder whether this need always be the case. This curvature follows directly from the assumptions on the component parts of the curve.

First, there must be some level of inspection above which $E(\Sigma)$ rises. Intuitively, this is so because the frequency with which aliens slip through the ports, $l(1-p)$ eventually approaches an asymptote – perhaps zero, perhaps a positive frequency—while the cost of inspectors continues to rise at rate k. That is, some point exists beyond which adding more inspectors is doing almost nothing to make imports safer, but they still cost k each.

Formally, as Σ increases, $E'(\Sigma)$ goes to k. To see this, expand Ψ^*_Σ to rewrite the coefficient of d in $E'(\Sigma)$ as

$$x = \left[(1-p) {\left(l'\right)^2}\big/{l\,l''} - p \right] p' .$$

Since importers are not hyper-reactive, $0 < \left(l'\right)^2 / l\,l'' < 1$. The whole term in square brackets is thus bound between –1 and 1, while p' goes to zero as Σ increases. Hence $E'(\Sigma) = k + dx \rightarrow k + d \cdot 0 = k$.

Our assumptions on inspection and decontamination technology insure that $E(\Sigma)$ is twice differentiable, and because it is decreasing at the unbound inspection level and increasing as Σ goes to infinity, an application of the intermediate value theorem to its first derivative implies it has a minimum. Similarly, our assumptions on supply and demand curves imply that m' remains finite,, so the presence in of the import level as a coefficient implies that $\mathrm{B}(\Sigma)$ rises back to zero as the effective tariff approaches the prohibitive level.

The eventual upward curvature of the target augmented tariff is thus a necessary feature of the model, and it means we should take seriously the possibility that even a welfare-maximizing social planner would respond perversely to the binding of a tariff. Having lost the right to impose the socially optimal tariff (which, recall, was internalizing a genuine externality in trade) the social planner seeks to increase the augmented tariff with the only tool still at his disposal. But that tool – the inspection level - was already set to minimize the net social cost per import. Thus, having departed from the previously optimal inspection level, he finds his motive to impede trade increased. A similar increase occurs with each attempt to increase the effective tariff .In terms of our model, this describes a social planner attempting to adjust the *actual* augmented tariff to match a moving *target*. If the target always increased with increases in the inspection rate above the optimum, then the bound optimum augmented tariff would be above the unbound optimum augmented tariff, always. This is not the case for two reasons. First, with the tariff available it was optimal to leave the external cost of trade above its minimum, and use the tariff to internalize it; thus, the external cost of trade falls for a range near the unbound optimum inspection level. Second, the target includes the binding adjustment, so that it is always below the external cost.

Figure 1 suggest that a decrease in the optimal augmented tariff due to binding should be the usual case. Such a decrease always occurs if the bound optimum occurs on the downward sloping section of the target tariff curve, and in this sense we can say that the optimal augmented tariff is proven to decline if the tariff ceiling agreed to is only slightly below optimal tariff. It remains an open question, however, whether the elimination of a very large tariff can lead to so much additional inspection as to increase the optimal augmented tariff. But we show below that the *effective* tariff – that is, the augmented tariff plus the induced cost of decontamination activity – can indeed be increased by tariff binding, and this is so of both the optimum and the equilibrium.

III. B. The impact of tariff binding on the equilibrium inspection level in general

It is now straightforward to show that the equilibrium inspection level must also rise when the tariff is bound. In unbound equilibrium, the inspection level was set at the socially optimal level. The bound social optimum is already higher than this. The import competing industry will only offer contributions for policies that result in effective tariffs above the social optimum. Hence, $\hat{\Sigma}_{eq} \geq \hat{\Sigma}_{opt} > \tilde{\Sigma}_{opt} = \tilde{\Sigma}_{eq} \Rightarrow \hat{\Sigma}_{eq} > \tilde{\Sigma}_{eq}$.

One might also want to know what happens to the level of disguised protectionism – that is, the difference between optimum and equilibrium, whether in units of inspection or import price – and this turns out to be far from trivial. In fact, it has no general answer. The reason for this is that the variable components of the disguised protection term, y and m', depend on the domestic price and therefore the effective tariff. The determination of the effective tariff, to which we return below, is itself a complex matter, depending on how the augmented tariff (in terms of which our equilibrium condition is written) varies with the costs of decontamination, $c\Psi$. In addition, the impact of the effective tariff on y/m' may be in either direction and need not be monotonic.

If the import demand curve is allowed to become, locally, almost perfectly elastic or inelastic, and to switch from one extreme to the other without limit, then both the level of disguised protection and the binding adjustment can fluctuate wildly. Further, these fluctuations are not closely tied to one another – the binding adjustment is independent of a and the equilibrium level of protectionism is independent of the level of demand. Beyond observing the likelihood that many sorts of behavior can emerge from this model, we would like to gain more insight into what is normal – i.e., what happens when import demand is not very unusual? We therefore add the assumption that both supply and demand are linear; and before turning to new questions, we illustrate the results shown already in an alternative geometry made possible by this assumption, and similar to one familiar from standard texts.

IV. The case of linear supply and demand

IV. A. The impact of tariff binding on the optimal effective tariff with

Let demand be given by $D(p^D) = D_0 - bp^D$ and domestic supply by $y(p^D) = y_0 + sp^D$ with b,s>0. We then have constant slope for import demand of $m' = -(b+s)$. The usual (i.e., when there is no externality in trade) expression for the welfare loss from an tariff of t is the sum of the area of the two triangles under the supply and demand curves between the pre-tariff and post-tariff prices, which is

$$\frac{1}{2}(s+b)(t)^2 = -\frac{1}{2}(t)^2 m'$$

Our equivalent to this measure, which we call the *effective tariff cost* of the policies, $ETC(t,\Sigma)$, is adjusted for the fact that effective tariff includes $c\Psi$, which is not collected by the government but spent on decontamination. The geometry is illustrated in

Figure 2. The usual measure is developed by noting that the whole trapezoid bounded by the supply and demand curves and the world and domestic price is lost surplus, but the rectangle equaling imports times tariff is refunded as a lump sum transfer. In our case, what is refunded is the tariff plus the fines, but this is still below the effective tariff.

$$ETC(t,\Sigma) = c\Psi m - \frac{1}{2}\left(t^e\right)^2 m'. \tag{21}$$

The effective tariff cost of the policies measures the pecuniary impact of an import price increase, excluding the cost of inspection at the port (which is treated separately because it does not effect the import price.) In the unbound equilibrium, optimal policy is to set inspections at a level independent of the quantity imported, and use the nominal tariff to internalize the remaining externality. When this is the tool to change the effective tariff, the marginal effective tariff cost is

$$METC_u = \frac{\partial ETC}{\partial t} = \left(c\Psi - t^e\right)m' \tag{22}$$

which is a linear function of the effective (and nominal) tariff with slope $-m'>0$.

The corresponding marginal benefit is the change in $E(\Sigma)m$, the inspection costs and environmental damage prevented as imports fall along the demand curve

$$METB_u = -\left(k\Sigma + dl\left(1-p\right)\right)m',$$

which is invariant with respect to the nominal tariff (given linear supply and demand), and thus also with respect to the effective tariff in the unbound case. Their intersection is the optimal effective tariff $\tilde{t}^o$, which differs from the equilibrium effective tariff only by the disguised protectionism term.

The binding of the tariff means that the relevant margin is the inspection level rather than the nominal tariff. With each increment of inspection the effective tariff increases by $F\left(lp' + p\,l'\Psi^*_\Sigma\right) + c\Psi^*_\Sigma$. As before, the c term is not collected revenue, and now this term changes with the effective tariff. Thus the component that is added to the traditional two-triangles deadweight loss from the tariff is now an increasing function of the effective tariff. Since we have assumed importers are not hyper-reactive, the effective tariff is a monotonic (increasing) and therefore invertible function of the decontamination level Ψ, which is in turn an invertible function of Σ.[12] We may thus write the marginal effective tariff cost, where the margin in question is t^e, as

$$METC_B = \frac{\partial ETC}{\partial \Sigma}\frac{\partial \Sigma}{\partial t^e} = c\frac{\partial \Psi}{\partial t^e}m + \left(c\Psi - t^e\right)m',$$

where

$$\begin{aligned}\frac{\partial \Psi}{\partial t^e} &= \Psi^*_\Sigma \Big/ \frac{\partial t^e}{\partial \Sigma} = \Psi^*_\Sigma \Big/ \left[F\,lp' + Fp\,l'\Psi^*_\Sigma + c\Psi^*_\Sigma\right] \\ &= \Psi^*_\Sigma \big/ F\,lp'\end{aligned}$$

where we use expression (5) to eliminate the terms including Ψ^*_Σ in the denominator. With the tariff bound, the marginal effective tariff benefit is no longer constant since both components are functions of Σ. As above, the fact that the effective tariff is an invertible function of the inspection level Σ and (5) allows us to eliminate the decontamination-mediated component of $\partial t^e / \partial \Sigma$.

$$\begin{aligned}METB_B &= METB_u - \frac{\partial \Sigma}{\partial t^e}\left(k - d\left(lp' + (1-p)\,l'\Psi^*_\Sigma\right)\right)m \\ &= -\left(k\Sigma + dl\,(1-p)\right)m' - m\left(k - d\left(lp' + (1-p)\,l'\Psi^*_\Sigma\right)\right)\Big/ F\,lp'\end{aligned}$$

Setting $METB_B = METC_B$ and rearranging to isolate $t^e - c\Psi$, which is by definition $t + F\,lp$, shows that the condition for the optimal bound effective tariff is condition (19) without the disguised protection term.

So far, this shows that a model restricted to linear supply and demand gives the same formulae as a more general model, and that these can be reached through alternative reasoning. We now turn to results demonstrated only for the fully linear case.

IV. B. The level of disguised protection with linear supply and demand

We have so far left the details of negotiation between government and lobby entirely in the background, considering only the implications of the efficiency property known to hold in truthful-strategy Nash equilibria of menu auctions. A bit more detail is now in order. A truthful strategy is one in which the lobby offers the government all the surplus it gains from the policy choice above a level called an *anchor*. Regardless of the policy chosen, the lobby members will receive net profits equal to those implied by the anchor; they therefore choose the highest anchor consistent with the government not dropping out of the game (Grossman and Helpman 1994). This has two immediate implications relevant here. First, the contribution schedule offered must be tangent to a government indifference curve in $t^e - C$ space. Since the slope of a truthful contribution schedule is the slope of the indirect profit function, which is industry supply, this means that at the equilibrium industry supply equals the government's marginal loss from a price increase – i.e., a times the marginal social loss from an increase in the effective tariff. Second, the contribution in equilibrium will exactly compensate the government for the accumulated social loss between the social optimum and equilibrium.

For the linear case described in the previous section, the marginal social loss is *METC-METB* (the margin of choice being in units of effective tariff). When the effective tariff is being adjusted by adjusting the nominal tariff, this is

$$\left(E\left(\tilde{\Sigma}\right)+c\tilde{\Psi}-t^{e}\right)m'.$$

The slope of marginal social loss as a function of t^e is thus $-m'$, which is constant; and the slope of the marginal government loss in $t^e - C/t^e$ space (i.e., the second derivative of a government indifference curve) is constant at $-am'$. This slope must be less than that of the supply curve if there is to be an interior equilibrium (the alternatives being the socially optimal and prohibitive tariffs) and it certainly will be so if $a \geq 1$ since $-m'$ is the sum of the absolute values of the slopes of demand and supply.

If the tariff is bound, the marginal social loss from increasing the effective tariff is

$$\begin{aligned}
&METC_B - METB_B \\
&= c\frac{\Psi^*_\Sigma}{F\,l\,p'}m + \left(c\Psi - t^e\right)m' + \left(k\Sigma + d\,l\,(1-p)\right)m' + m\left(k - d\left(l\,p' + (1-p)\,l'\Psi^*_\Sigma\right)\right)\Big/F\,l\,p' \\
&= \left(c\Psi - t^e + k\Sigma + d\,l\,(1-p)\right)m' + \left(c\Psi^*_\Sigma + \left(k - d\left(l\,p' + (1-p)\,l'\Psi^*_\Sigma\right)\right)\right)\frac{m}{F\,l\,p'}
\end{aligned}$$

$$= \left(\mathrm{B}\left(\Sigma\right) + E\left(\Sigma\right) + c\Psi - t^e\right)m'$$

which varies in slope as Σ varies with t^e. Using the observation $\partial\Sigma/\partial t^e = 1/F\,l\,p'$ (see derivation of $METC_B$), this slope is

$$\begin{aligned}
\frac{\partial MSL_B}{\partial t^e} &= \left(\mathrm{B}'(\Sigma) + E'(\Sigma) + c\Psi^*_\Sigma\right)\frac{m'}{F\,l\,p'} - m' \\
&= \left(\mathrm{B}'(\Sigma)\right)\frac{m'}{F\,l\,p'} + \left(\frac{\mathrm{B}(\Sigma)\,m'}{m} - 1\right)m'
\end{aligned} \tag{23}$$

Figure 3 shows the major features of the bound and unbound equilibria. The curves labeled $aMSL_B$ and $aMSL_U$ are the bound and unbound marginal social losses curves just described, multiplied by the government's relative weighting of social welfare a. The equilibrium contributions are the two shaded areas. (The fact that these do not overlap is purely for graphical clarity.)

We have drawn MSL_B curving downward i.e., $\partial^2 MSL_B \big/ \partial\left(t^e\right)^2 < 0$.[13] With this structure in hand, we illustrate the possibility of two types of perverse outcome. Each can be shown clearly to occur in the limiting case of perfectly inelastic supply. The illustrations should make it apparent that both perverse outcomes can happen when the supply curve has finite positive slope, but both become less likely as the marginal cost curve of a representative import competing firm becomes flatter. The first perverse outcome occurs if binding the nominal tariff increases the level of disguised protectionism -- i.e., the difference between equilibrium and optimum effective tariff. The second occurs when binding the nominal tariff reduces social welfare in bound equilibrium below that in unbound equilibrium.

First, since the augmented tariff is $t^e_{eq} - c\Psi_{eq}$, (17) and (19) imply that in both the unbound and bound cases

(24) $$t^e_{eq} - c\Psi_{eq} - \left(t^e_{opt} - c\Psi_{opt}\right) = -\,{}^{y}\!\big/_{am'}.$$

For perfectly inelastic domestic supply and linear demand, this is a constant; both y and m' have the same value at optimum and equilibrium. With perfectly inelastic supply and linear import demand, the right side of (24) is invariant. Therefore, setting the left side in the unbound case (~) equal to that left side in the bound case (^) and rearranging,

$$\hat{t}^e_{eq} - \hat{t}^e_{opt} - \left(c\hat{\Psi}_{eq} - c\hat{\Psi}_{opt}\right) = \tilde{t}^e_{eq} - \tilde{t}^e_{opt} - \left(c\tilde{\Psi}_{eq} - c\tilde{\Psi}_{opt}\right).$$

But in unbound equilibrium, the inspection level is set optimally, so $\left(c\tilde{\Psi}_{eq} - c\tilde{\Psi}_{opt}\right) = 0$. Hence $\hat{t}^e_{eq} - \hat{t}^e_{opt} - \left(c\hat{\Psi}_{eq} - c\hat{\Psi}_{opt}\right) = \tilde{t}^e_{eq} - \tilde{t}^e_{opt}$.Since the inspection rate is higher in bound equilibrium than in bound optimum, the difference in parentheses is positive and $\hat{t}^e_{eq} - \hat{t}^e_{opt} > \tilde{t}^e_{eq} - \tilde{t}^e_{opt}$.

This means that if Figure 3 were redrawn for the case of perfectly inelastic supply, the bottom of the curved shaded area would be longer than the bottom of the triangle. And, of course, the height of the two shaded areas would be equal. Thus, given the downward-curving boundary of the bound contribution area, the triangle representing the unbound contribution would fit entirely within the area representing the bound contribution; that is, this curvature is sufficient but not necessary to insure that binding the tariff results in a larger political contribution.

The possibility of the second perverse outcome follows immediately. Since the lobby precisely compensates the government for lost social welfare, in both the bound and unbound cases, we have

$$W_{opt} = W_{eq} + \frac{1}{a} C_{eq}.$$

As was shown long ago by Le Chatalier, a constrained optimum cannot exceed the corresponding unconstrained optimum, hence know that $\tilde{W}_{opt} \geq \hat{W}_{opt}$. Therefore, if binding the tariff increases the lobbies contribution, it must decrease equilibrium welfare.

Finally, a third perverse outcome is possible – binding the tariff can actually increase the effective tariff in equilibrium, contrary to what was assumed in the illustrations above. We have, unfortunately, no interesting geometry to accompany this result; that such a thing is possible is shown only by fact that we are able to find examples in which it occurs. One such example is shown as the Fully Perverse Case in Table 1. The assumptions underlying the calculation are given in the bottom row of the table, except for the supply curve in the top row. The perversion is apparent in the fact that $\hat{t}^e_{eq} > \tilde{t}^e_{eq}$ and $\hat{t}^e_{opt} > \tilde{t}^e_{opt}$; that is, binding (at zero) the nominal tariff has raised both the optimum and equilibrium effective tariff. The second example reported shows that this need not always occur. It is called the Half Perverse Case because binding the tariff still lowers social welfare in equilibrium, thus substantiating the above claim that the second type of perverse outcome is possible.

In the cases shown, the only difference between the circumstances is that the supply curve is slightly steeper in the Fully Perverse Case. This is one of many sources of variation capable of shifting the sign of this component of the outcome, which is why we have no enlightening geometry to offer. We can, however, offer some simple intuition as to how this variation in outcome is possible, building on the problem facing an altruistic functionary discussed above. That functionary, recall, was seen to be chasing a target augmented tariff that shifted with each change in the acutal autmented tariff. A functionary peddling political influence faces the same problem, except that his target is shifted by the disguised protection term which . One force tends to make the target rise as the effective tariff rises: since the action taken to increase the effective tariff drives the inspection level away from that which minimized social cost, imports do more harm per unit than before. Attempting to respond to this by making imports more expensive, however, only makes the problem worse, and this is what operates in the opposite direction. That is, the increase in the *total* damage done by an import shipment drives him towards a higher effective tariff, but is countered by the increase in the *marginal* cost, in which the margin is the effective tariff. The total and marginal cost have, of course, many parameters in common, and one might suppose that one force or the other will always predominate. The calculations above show that this is not the case, and that one need not seek extreme circumstances to get either outcome.

V. Conclusions

Most of the market failures that are exacerbated by increasing global trade are in principle best addressed by policies directed at the source of market failure rather than by trade policies. This paper deals with the exceptions – externalities arising from the very act of shipping things, the most important example being the movement of unwanted species with the cargo. Examples include diseases affecting humans, crops and livestock, as well as invasive species that can damage valued ecosystems and interfere with productive activity. [14]

We show that there are serious problems with attempts to deal with such externalities in trade through the traditional approach, in which countries are given broad latitude to set standards over the safety of their imports but agree to forgo policies that directly restrict trade. When a country agrees to a limit on its tariff, but is free to set the level of inspection stringency, the political pressures that would otherwise drive the tariff above the optimum instead drive stringency above the optimum. Because inspections are a less efficient tool for responding to these political pressures, three perverse consequences are possible. First, the effective tariff – that is, the difference between domestic and world price of imports – can actually rise. Second, even if the effective tariff falls, the level of *disguised protectionism* - measured as the difference between equilibrium and optimum effective tariff - may rise. Finally, social welfare can fall. For the case of linear supply and demand, the second of these perverse effects must always occur; and if the domestic supply curve is very steep, so must the third.

Our framework is, of course, highly simplified. Among other things, there is no place in it for an importer to challenge an inspection regime, exposing a nation to retaliatory tariffs if international authorities deem the policy not to have been formed in good faith. There is thus no room for environmental organizations to weigh in, or for judges to apply common sense. These factors may render the real-world trade rules somewhat less prone to the perverse outcomes we describe than is the world of our model. But in the absence of transparent standards for the valuation of environmental damage, the application of any such super-national authority is necessarily an assertion that a world court knows better than domestic politicians what is in the interest of a nation's people, or is purer in its dedication to those interests. It seems unlikely that such assertions will generally prevail. The current preference given to policies that are on their face less trade restrictive than alternative approaches to contaminated imports is therefore likely to favor, at least sometimes, practices that both diminish social welfare and impede trade more than would more openly protectionist alternatives.

APPENDIX

A: Proof that $E(\Sigma)$ is globally concave, and a sufficient condition for concavity of the unbound objective functions.

$\frac{\partial^2 \Lambda}{\partial \Sigma^2} = d\left[l p' - (1-p)\, l'' \left(\Psi_\Sigma^*\right)^2 + 2\, l' p' \Psi_\Sigma^* \right] - \left[c - d\,(1-p)\, l' \right] \Psi_{\Sigma\Sigma}^*$. This is also the second derivative $E(\Sigma)$ and of f the unbound maximization of social welfare is the same. Both are negative globally as long since importers are not hyper-reactive, as can easily be verified from the assumed and proven signs of the components.

$\frac{\partial^2 \Lambda}{\partial t^2} = \frac{y' m' - y m''}{a\left(m'\right)^2} - 1$. The second derivative of the unbound maximization of social welfare is simply -1. $\frac{\partial^2 \Lambda}{\partial t^2} < 0$ as long as

(A1) $$m'' > -\frac{a\left(m'\right)^2 - y' m'}{y}.$$

The cross-partial derivative is zero. This is most easily seen by noting that no function of tariff appears in the first order condition on Σ in (18). The inspection level does appear in the condition for τ; but taking the derivative of $\frac{\partial \Lambda}{\partial t}$ with respect to Σ, and substituting in from (18) and (5) shows it to be zero.

The social welfare function is therefore globally concave, and the objective function maximized in truthful Nash equilibrium (Λ) is concave wherever condition (A1) is fulfilled. This condition hold globally linear import demand ($m'' = 0$) or constant elasticity import demand ($m'' > 0$).

B: Derivation of (19).

Set (13) to zero

$$m_\Psi = \frac{1}{\Psi_\Sigma^*}\left(\left[(d+F)\,l\,p'-k\right]am - m_p F\,l\,p'\right)$$

Substitute for m_Ψ in (15) and set to zero

$$\frac{1}{\Psi_\Sigma^*}\left(\left[(d+F)\,l\,p'-k\right]am - m_p F\,l\,p'\right) - m_p c + \left[am\left(Fp - d\,(1-p)\right) - m_p Fp\right] l' = 0$$

Collect the terms in m_p and am

$$-\left[\frac{1}{\Psi_\Sigma^*}F\,l\,p' + c + Fp\,l'\right]m_p + \left(\frac{1}{\Psi_\Sigma^*}\left[(d+F)\,l\,p'-k\right] + \left(Fp - d\,(1-p)\right) l'\right)am = 0$$

$$m_p = \frac{\left(\frac{1}{\Psi_\Sigma^*}\left[(d+F)\,l\,p'-k\right] + \left(Fp - d\,(1-p)\right) l'\right)}{\frac{1}{\Psi_\Sigma^*}F\,l\,p' + c + Fp\,l'}\,am$$

From (5) $c + Fp\,l' = 0$. Using this in both the numerator and denominator,

$$m_p = \left(\frac{\left[(d+F)\,l\,p'-k\right] - \left(c + d\,(1-p)\,l'\right)\Psi_\Sigma^*}{F\,l\,p'}\right)am$$

Substitute for m_p in (16) and set to zero

$$\frac{\left(\left[(d+F)\,lp'-k\right]-\left(c+d\,(1-p)\,l'\right)\Psi_{\Sigma}^{*}\right)}{F\,lp'}am+y+\left(t+F\,lp-k\Sigma-dl\,(1-p)\right)am'-am=0$$

$$\left[1-\frac{\left(\frac{1}{\Psi_{\Sigma}^{*}}\left[(d+F)\,l\,p'-k\right]-\left(c+d\,(1-p)\,l'\right)\Psi_{\Sigma}^{*}\right)}{F\,l\,p'}\right]am\Psi_{\Sigma}^{*}=y+\left(t+F\,l\,p-k\Sigma-d\,l\,(1-p)\right)am'$$

Substitute $1=\frac{F\,l\,p'}{F\,l\,p'}$

$$\left[\frac{F\,lp'-\left(\left[(d+F)\,l\,p'-k\right]-\left(c+d\,(1-p)\,l'\right)\Psi_{\Sigma}^{*}\right)}{F\,l\,p'}\right]am=y+\left(t+F\,l\,p-k\Sigma-d\,l\,(1-p)\right)am'$$

Note that the numerator contains $F\,l\,p'-F\,l\,p'$

$$-\left[\frac{d\,l\,p'-k-\left(c+d\,(1-p)\,l'\right)\Psi_{\Sigma}^{*}}{F\,l\,p'}\right]am=y+\left(t+F\,l\,p-k\Sigma-d\,l\,(1-p)\right)am'$$

Dividing through by am' and rearranging so that the augmented tariff $t+F\,lp$ is on the left hand side gives expression (19).

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Table 1: Examples showing that eliminating nominal tariff can raise or lower the effective tariff

	Fully Perverse Case	Half Perverse Case
$y(p^D)$	$10+9p^D$;	$10+7.5\ p^D$
$\tilde{\Sigma}_{opt}$, $\tilde{\Sigma}_{opt}$	1.075	1.075
$\hat{\Sigma}_{opt}$	1.318	1.273
$\hat{\Sigma}_{eq}$	1.423	1.323
$\tilde{t}^e_{opt}$	29.240	29.240
$\hat{t}^e_{opt}$	29.472	27.785
$\tilde{t}^e_{eq}$	31.049	30.999
$\hat{t}^e_{eq}$	32.713	29.646
Unbound Welfare	8280	8283
Bound Welfare	438	1486
FEATURES IN COMMON	$\pi=(\Sigma-1)/\Sigma$; $\lambda=1-(\Psi-1)/\Psi$; c=9; k=10; $\overline{F}=100$; $\delta=10$; $p^W=1$; $a=15$ $D(p^D)=500-2p^D$; $\hat{t}=0$	

Figure 1: Optimal Inspection with a tariff bound at zero

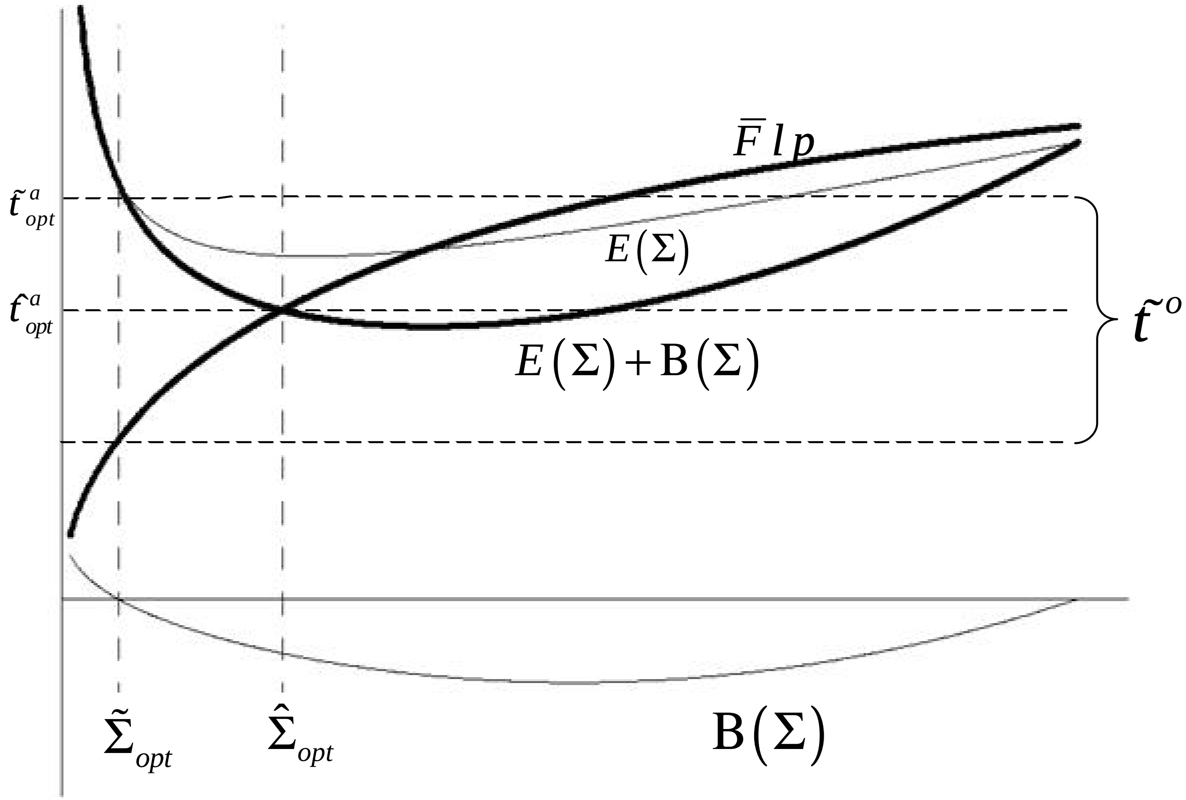


Figure 2: Effective Tariff Costs

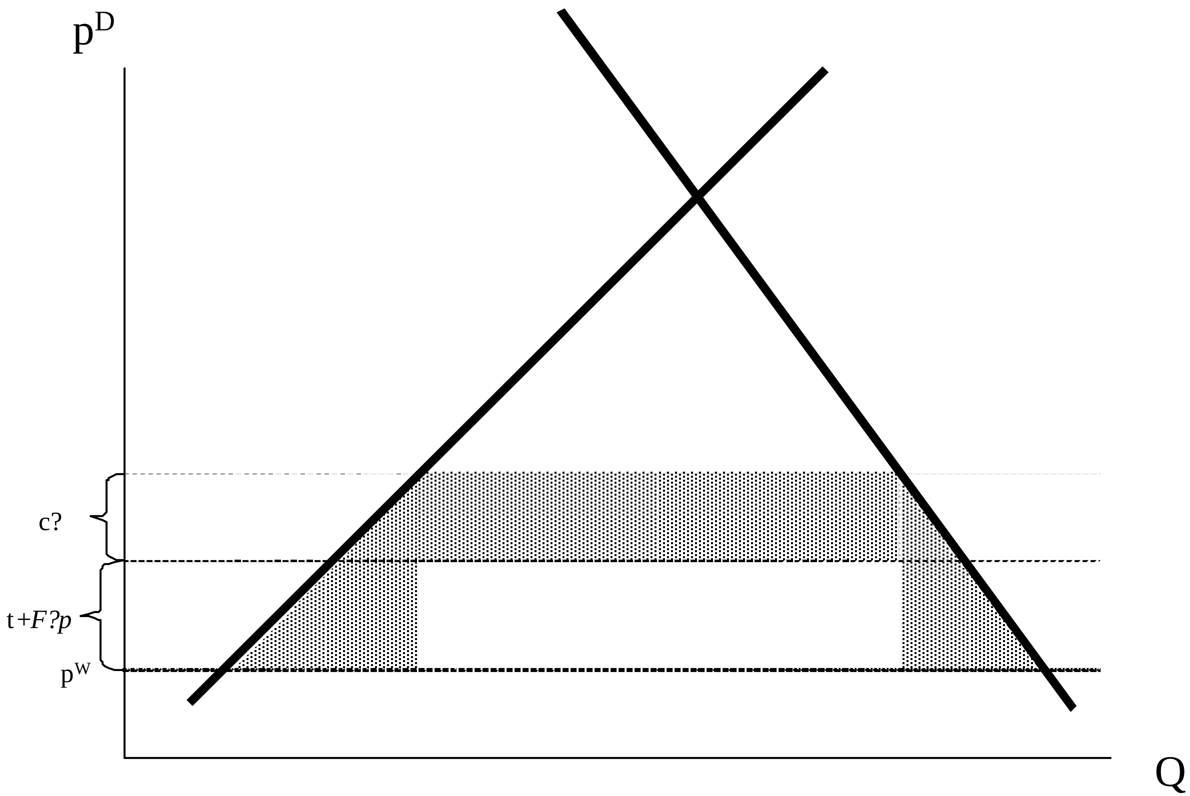
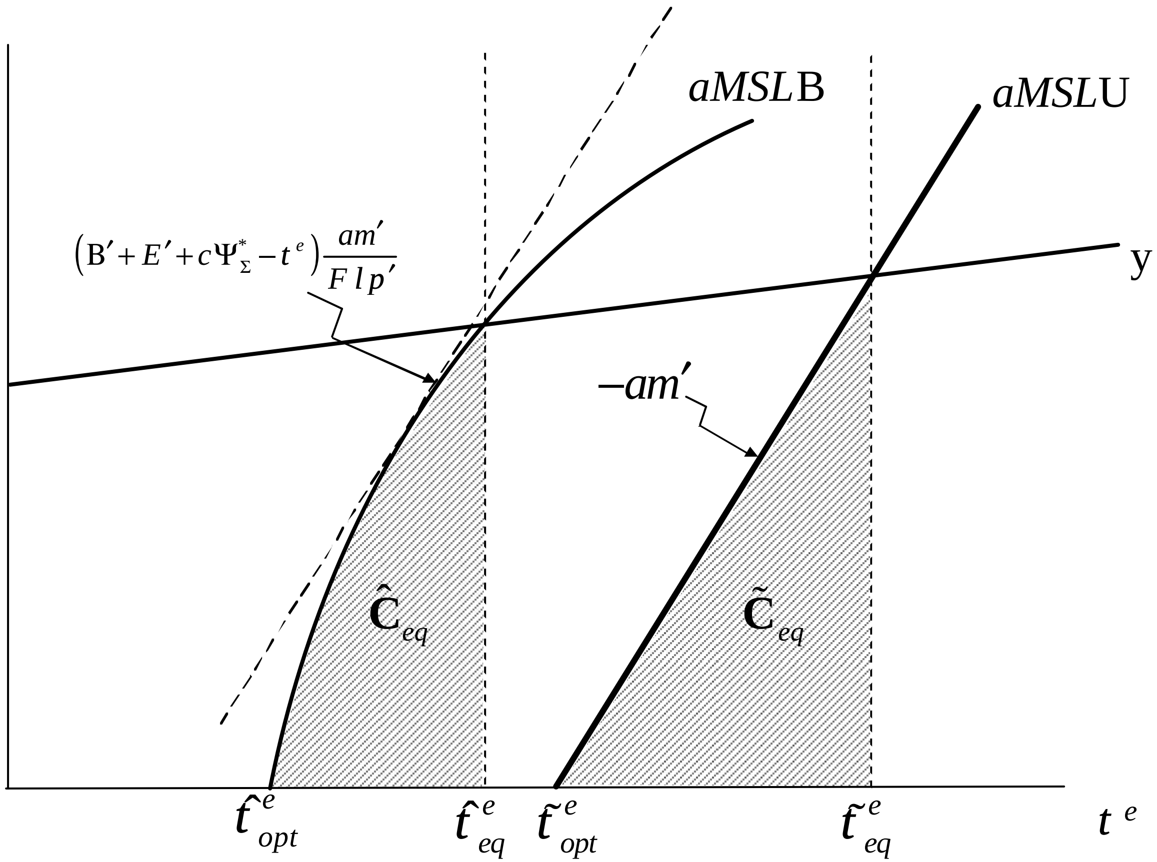


Figure 3: Truthful Nash Equilibria



[1] In the United States, President Clinton's Invasive Species Executive Order 13112 and the 2001 National Invasive Species Council Management Plan define an invasive species as: "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (Section 1(f), EO 13112). They defined "alien species" as: "with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem" (Section 1(a), EO 13112). Invasive alien species (IAS) is becoming a major issue within the Asian-Pacific Economic Cooperation (APEC) organization. For instance, in September 2005, APEC convened a workshop to develop an overall strategy to deal with IAS issues within this "intergovernmental grouping" of 21 countries with nearly 3 billion people who generate about 50 percent of world trade.

[2] This is by no means a foregone conclusion. WTO dispute resolution panels have ruled against trade measures in this class several times. They have been quite consistent, however, in defending the right of a nation to choose any level of safety, regardless of economic costs.

[3] That is not the only purpose: see Kyle Bagwell and Robert Staiger (2001) for a less idealistic discussion of the function of international trade law.

[4] The basic GH model has become the standard textbook theory of the political economy of trade policy, and has successfully predicted the structure of protection in the United States (Pinelopi Goldberg and Giovanni Maggi 1999, Kishore Gawande and Usree Bandyopadhyay (2000)) and Turkey (Devashish Mitra, Dimitrios Thomakos and Mehmet A. Ulubascediloglu 2002).

[5] In the GH framework, this is almost the same as the less restrictive assumption that no other organized group care about this particular aspect of policy. See Michael Margolis, Jason F. Shogren and Carolyn Fischer (2004) for a multi-sector model of disguised protectionism in an invasive species context. See Troy Aidt (1998) for a discussion of how environmental lobbies fit into the GH framework.

[6] The Bernheim and Whinston results actually refer to *locally* truthful strategies, allowing for the possibility that the contribution schedule may not be truthful far from equilibrium, and the GH results on equilibrium tariff levels require only local truthfulness. There is, however, no particular reason for lobbies to depart from

truthfulness far from equilibrium. Since the government's objective function is assumed common knowledge, the lobbies know where the equilibrium will be, and it is a matter of indifference to them what they promise for far-from-equilibrium policies. Assuming global truthfulness thus seems only a trivial loss of generality, and greatly eases exposition.

[7] The more general result to which we refer is that the joint payoff to auctioneer and any *one* bidder is maximized, given the contribution schedules of all other bidders. (GH Proposition 1-C and Bernheim and Winston 1986 Lemma 2.)

[8] To see this, maxmize W rather than $W_I + aW$ with the same constraints.

[9] With F now effectively fixed, the second order condition for maximization is fulfilled provided Λ is concave in Σ,τ. We show in the Appendix that this is so in the neighborhood of any extremum, as long as $m'' > -\frac{am' - y'}{y} m'$; i.e., as long as the import demand curve does not bend sharply downwards. In the unlikely case that such extreme curvature does hold globally, the truthful-strategy Nash equilibrium tariff will be prohibitive; otherwise, both the truthful-strategy Nash equilibrium that maximizes Λ and the social optimization problem are characterized by one maximum and no interior minimum.

[10] We cannot explicitly consider incentives for trade partners to weigh in without adding substantially to the complexity of the model in this paper, since we have treated importers as perfect competitors, so that whatever the policy of the importing country, their profits are zero. Such an analysis would add an externality in trade to Grossman and Helpman's (1997) model.

[11] In the case shown, the target has negative slope, but this is not necessary.

[12] If we allowed for hyper-reactive importers, things would get extremely complex – the increase in inspections may induce so much decontamination that the effective tariff falls. Note, however, that hyper-reactivity is a necessary but not a sufficient condition for this perverse effect. Importers are hyper-reactive if $(l')^2 > l\,l''$, but they are only reactive enough to lower the effective tariff if $p'(l')^2 > l\,l''$.

[13] Our set of assumptions may be insufficient to insure that this holds in general. The second derivative of the binding adjustment includes terms in the third derivatives of $E(\Sigma)$ and $\Psi^*(\Sigma;\bar{F})$ which do not appear to have unambiguous sign or negligible magnitude. The simulation results discussed briefly below, however, are sufficient to show that for at least some functional forms and parameter values consistent with the underlying logic of the model, the second order curvature is as shown.

[14] The invasion of zebra mussels in the Great Lakes is probably the best known example of this last sort of damage, and is estimated to cost U.S. industry some $100 million per year in control costs (Pimentel et. al. 1999).Other sorts of cost, such as environmental damage, are must less straightforward to measure, but published attempts (for all alien species in the United States) range from about $1.1 billion (Office of Technology Assessment 1993) to nearly $120 billion per year (Pimentel et. al. 2005). Since the smaller of these estimates is nearly equal to the entire annual value of US merchandise imports (~$1.3 billlion in 2003) there should be little doubt that the scale of the problem is sufficient to justify policies that may have substantial trade-retarding effects.